We Claim:

1. A method of configuring and tracking an array of probes comprising:

generating at least two movable optical traps within a vessel;

providing at least two probes within the vessel;

selecting at least two of the probes for inclusion in an array of probes contained within the optical traps;

trapping each of the selected probes with one of the optical traps to configure the array of probes contained within the optical traps; and,

tracking the position of at least one of the trapped probes in the array by monitoring the position of the optical trap which contains it.

2. The method of claim 1, further comprising altering the position of at least one tracked probe by moving the optical trap containing the tracked probe.

3. The method of claim 1, wherein the optical traps are formed of two or more of optical tweezers, optical vortices, optical bottles, optical rotators, or light cages.

4. The method of claim 2, wherein each optical trap is independently movable.

5. The method of claim 2, wherein the movement of each optical trap is controlled by a computer.

6. The method of claim 4, wherein the movement of each optical trap is controlled by a computer.

7. The method of claim 4, wherein at least one of the probes is bound to a substrate labeled with a wavelength specific marker and the at least one bound probe is selected by spectroscopically measuring the marker and using the spectroscopic measurement to select the at least one probe.

8. The method of claim 4, wherein at least two of the probes have binding or reactivity characteristics that differ from one another and at least one of the probes is selected by segregating the probe based on its different binding or reactivity characteristic by moving the

probe to a pre-determined location within the vessel and using the location of the segregated probe to select the probe.

9. The method of claim 8, wherein the predetermined location is a physical sub-cell.

10. The method of claim 8, wherein the predetermined location is an optical sub-cell.

11. The method of claim 1 further comprising introducing into the vessel at least one target and determining the reaction or lack thereof of each of the trapped probes with each of the targets.

12. The method of claim 11, wherein the trapped probe is a biological material.

13. The method of claim 11, wherein the trapped probe is a chemical compound.

14. The method of claim 12, wherein the target is a biological material.

15. The method of claim 12, wherein the target is a chemical compound.

16. The method of claim 13, wherein the target is a biological material.

17. The method of claim 13, wherein the target is a chemical compound.

18. The method of claim 12 wherein the trapped probe is an oligonucleotide, a polynucleotide, a protein, a polysaccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or combinations thereof.

19. The method of claim 14 wherein the target is an oligonucleotide, a polynucleotide, a protein, a polysaccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

20. The method of claim 16 wherein the target is selected from one or more of the group consisting of an oligonucleotide, a polynucleotide, a protein, a polysaccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

21. The method of claim 1 further comprising the probes are all bound to a substrate.

22. The method of claim 1 further comprising the probes are all directly trapped by the optical trap.

23. The method of claim 1 further comprising at least some probes are bound to a substrate and at least some probes are unbound to substrate.

24. The method of claim 21, further comprising altering the position of at least two of the tracked probes in the array by moving the optical traps containing the probes.

25. The method of claim 1, further comprising producing an optical data stream of data corresponding to the identity and position of at least one of the optical traps.

26. The method of claim 24, wherein each optical trap is independently movable.

27. The method of claim 24 wherein the movement of each optical trap is controlled by a computer.

28. The method of claim 25, further comprising receiving the optical data-stream with a computer.

29. The method of claim 28, further comprising analyzing the optical data stream with the computer.

30. The method of claim 29, wherein the computer directs the movement of at least one optical trap based on the analysis of the optical data stream.

31. The method of claim 25, further comprising converting the optical data-stream to a video signal.

32. The method of claim 31, further comprising receiving the video signal with a computer.

33. The method of claim 32, further comprising analyzing the video signal with the computer.

34. The method of claim 33, further comprising using the computer to direct the movement of one or more optical traps based on the analysis of the video signal.

35. The method of claim 31, wherein the video signal is used to produce an image.

36. The method of claim 35, further comprising an operator viewing the image and directing the movement of one or more optical traps based on the viewing of the image.

37. The method of claim 25, wherein the data is spectroscopic data.

38. The method of claim 37, further comprising using a computer to direct the movement of one or more optical traps based on an analysis of the spectroscopic data.

39. The method of claim 24, wherein the optical traps are formed of two or more of optical tweezers, optical vortices, optical bottles, optical rotators, or light cages.

40. The method of claim 26 wherein the movement of each optical trap is controlled by a computer.

41. The method of claim 24, wherein at least one of the probes is selected by spectroscopically measuring the marker and using the spectroscopic measurement to select the at least one probe.

42. The method of claim 24, wherein at least two of the probes have binding or reactivity characteristics that differ from one another and at least one of the probes is selected by segregating the probe based on its different binding or reactivity characteristic by moving the probe to a pre-determined location within the vessel and using the location of the segregated probe to select the probe.

43. The method of claim 42, wherein the predetermined location is a physical sub-cell.

44. The method of claim 42, wherein the predetermined location is an optical sub-cell.

45. The method of claim 169, wherein the trapped probe is a biological material.

46. The method of claim 169, wherein the trapped probe is a chemical compound.

47. The method of claim 46, wherein the target is a biological material.

48. The method of claim 46, wherein the target is a chemical compound.

49. The method of claim 45, wherein the target is a biological material.

50. The method of claim 45, wherein the target is a chemical compound.

51. The method of claim 45, wherein the trapped probe is an oligonucleotide, a polynucleotide, a protein, a polysaccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or combinations thereof.

52. The method of claim 47, wherein the target is an oligonucleotide, a polynucleotide, a protein, a polysaccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

53. The method of claim 49, wherein the target is selected from one or more of the group consisting of an oligonucleotide, a polynucleotide, a protein, a polysaccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

54. The method of claim 24 wherein the probes are all bound to a substrate.

55. The method of claim 24 wherein the probes are all unbound to a substrate.

56. The method of claim 24 wherein at least some probes are bound to a substrate and at least some probes are unbound to substrate.

57. A method of assaying biological material comprising:
generating at least two movable optical traps within a vessel;
providing a fluid media in the vessel;
providing at least two probes for biological materials within the fluid media;
selecting at least two of the probes for inclusion in an array;
trapping each of the selected probes with one of the optical traps;
introducing into the vessel at least one target comprised of a biological material; and,
determining the reaction or lack thereof, of each of the trapped probes with each of the targets.

58. The method of claim 57, further comprising tracking the position of at least one of the trapped probes by monitoring the position of the optical trap which contains it.

59. The method of claim 57, wherein the trapped probe is comprised of a biological material.

60. The method of claim 57, wherein the trapped probe is comprised of a chemical compound.

61. The method of claim 59, wherein the trapped probe is an oligonucleotide, a polynucleotide, a protein, a polysaccharide, a ligand, a cell, an antibody, an antigen, a cellular

organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or combinations thereof.

62. The method of claim 57, wherein the target is an oligonucleotide, a polynucleotide, a protein, a polysaccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

63. The method of claim 57, further comprising producing an optical data stream of data corresponding to the identity and position of at least one of the optical traps.

64. The method of claim 63 further comprising altering the position of at least one trapped probe in the array by moving the optical trap containing the probe.

65. The method of claim 64, wherein each optical trap is movable independently.

66. The method of claim 64 wherein the movement of each optical trap is controlled by a computer.

67. The method of claim 63 further comprising receiving the optical data-stream with a computer.

68. The method of claim 67 further comprising analyzing the optical data stream with the computer.

69. The method of claim 68 further comprising using the computer to direct the movement of one or more optical traps based on the analysis of the optical data stream.

70. The method of claim 63 further comprising converting the optical data-stream to a video signal.

71. The method of claim 70 further comprising receiving the video signal with a computer.

72. The method of claim 71 further comprising analyzing the video signal with the computer.

73. The method of claim 72 further comprising using the computer to direct the movement of one or more optical traps based on the analysis s of the video signal.

74. The method of claim 70, wherein the video signal is used to produce an image.

75. The method of claim 74 further comprising an operator viewing the image and directing the movement of one or more of the optical traps based on the viewing of the image.

76. The method of claim 63, wherein the data is spectroscopic data.

77. The method of claim 76, further comprising using a computer to direct the movement of one or more optical traps based on an analysis of the spectroscopic data.

78. The method of claim 63 wherein the optical traps are formed of two or more of optical tweezers, optical vortices, optical bottles, optical rotators, and light cages.

79. The method of claim 63 wherein at least one of the probes is bound to a substrate.

80. The method of claim 63 wherein at least one of the probes is unbound to a substrate.

81. The method of claim 79, wherein all the substrate bound probes having the same binding or reactivity characteristic are labeled with the same markers.

82. The method of claim 81, wherein at least one of the markers is a wavelength specific dye.

83. The method of claim 82, wherein at least one of the substrate bound probes is selected by measuring the spectral response of the wavelength specific dye and using the spectral measurement to select the at least one probe.

84. The method of claim 63, wherein at least two of the probes have binding or reactivity characteristics that differ from one another and at least one of the probes is selected by segregating the probe based on its different binding or reactivity characteristic, by moving the probe to a pre-determined location within the vessel and using the location of the segregated probe to select the probe.

85. The method of claim 63, wherein the predetermined location is a physical sub-cell.

86. The method of claim 84, wherein the predetermined location is an optical sub-cell.

87. A method of configuring an array of probes comprising:
generating at least two movable optical traps within a vessel;
providing at least two probes within the vessel; and,
configuring an array of at least two probes by selecting each probe with one of the optical traps.

88. A method of configuring and reconfiguring an array of probes comprising:
directing a focused beam of light at a phase patterning optical element to form a plurality of beamlets emanating from the phase patterning optical element;
directing the plurality of beamlets at the back aperture of a focusing lens to pass the beamlets through the focusing lens and converge the beamlets emanating from the focusing lens to generate movable optical traps within a vessel;
providing a plurality of probes within the vessel;
selecting at least two of the probes for inclusion in the array of probes contained within the optical traps;
trapping each of the selected probes with one of the optical traps to configure the array of probes contained within the optical traps; and
altering the position of at least one of the probes contained within the optical traps by moving the optical trap containing the probe to reconfigure the array of probes contained within the optical traps.

89. The method of claim 90 wherein the phase patterning optical element has a static surface.

90. The method of claim 91 wherein the static surface is comprised of two or more discreet regions.

91. The method of claim 90 wherein the position of at least one of the probes_contained within the optical traps is altered by changing the discreet region of the static surface to which the beam of light is directed.

92. The method of claim 89 wherein the static surface is substantially continuously varying.

93. The method of claim 89 wherein the position of the at least one optical trap is altered by changing the region of the static surface to which the beam of light is directed .

94. The method of claim 89 wherein the beam altering optical element is a grating, a hologram, a stencil, a light shaping holographic filter, a lens, a mirror, a prism, or a waveplate.

95. The method of claim 90 wherein each discreet region is a grating, a hologram, a stencil, a light shaping holographic filter, a lens, a mirror, a prism, or a waveplate.

96. The method of claim 88 wherein the phase patterning optical element is dynamic.

97. The method of claim 96 wherein the position of the at least one of the probes contained in the optical traps is altered by varying the dynamic phase patterning optical element.

98. The method of claim 97 wherein the form of at least one of the optical traps is changed by varying the dynamic phase patterning optical element.

99. The method of claim 97, wherein the changed optical trap is an optical tweezer, a optical vortex, an optical bottle, an optical rotator, or a light cage.

100. The method of claim 91 wherein the form of at least one of the optical traps is changed by moving the discreet static surface.

101. The method of claim 100, wherein the changed optical trap is an optical tweezer, an optical vortex, an optical bottle, an optical rotator, or a light cage.

102. The method of claim 97 wherein the varying of the dynamic phase patterning optical element is a change in a hologram encoded on its surface.

103. A system for forming and tracking optical traps containing probes comprising:

a light source for producing a focused beam of light;

a substantially transparent vessel;

an image illumination source for producing a beam of light illuminating contents of the vessel;

a beam splitter for directing;

a phase patterning optical element for receiving the focused beam of light originating from the light source and diffracting it into at least two beamlets, the phase patterning optical element having a surface for directing each of the beamlets at a back aperture of a focusing lens, the surface being alterable to change the phase profile and/or orientation of at least one of the beamlets;

the focusing lens for converging each of the beamlets to form optical traps for containing probes; and

a monitor for receiving the beam of light illuminating contents of the vessel and tracking the movement and contents of at least one optical trap.

104. The system of claim 103 further comprising the vessel includes an inlet port.

105. The system of claim 103 further comprising the vessel includes an outlet port.

106. The method of claim 8 wherein the probes are segregated using movement by optical traps, flow channels or micro-capillaries.

107. The method of claim 42 wherein the probes are segregated using movement by optical traps, flow channels or micro-capillaries.

108. The method of claim 84 wherein the probes are segregated using movement by optical traps, flow channels or micro-capillaries.

109. The method of claim 63 wherein the targets are selected from one or more of the group consisting of oligonucleotides, polynucleotides, proteins, polysaccharides, ligands, cells, antibodies, antigens, cellular organelles, lipids, blastomeres, aggregations of cells, microorganisms, peptides, cDNA and RNA.

110. The method of claim 9 wherein the probes are segregated using movement by optical traps, flow channels or micro-capillaries.

111. The system of claim 103, wherein the phase patterning optical element is dynamic and which further comprises:

a first computer to control the diffraction by the phase patterning optical element; and,

a second computer to maintain a record of each probe contained in each optical trap.

112. The method of claim 2, wherein the movement of the trapped probes are tracked based on pre-determined movement of each optical trap caused by encoding the phase patterning optical element.

113. A system for forming and tracking optical traps containing probes bound to targets comprising:

a plurality of probes bound to targets;

a light source for producing a focused beam of light;

a substantially transparent vessel;

an image illumination source for producing a beam of light illuminating contents of the vessel;

a beam splitter for directing the beam of focussed light originating from the light source and the beam of light illuminating contents of the vessel;

a phase patterning optical element for receiving the focused beam of light originating from the light source and diffracting it into at least two beamlets, the phase patterning optical element having a surface for directing each of the beamlets at a back aperture of a focusing lens, the surface being alterable to change the phase profile and/or orientation of at least one of the beamlets;

the focusing lens for converging each of the beamlets to form optical traps containing the probes bound to the targets; and

a monitor for receiving the beam of light illuminating contents of the vessel and tracking the movement and contents of at least one optical trap.

114. The system of claim 113, wherein the probe is a biological material.

115. The system of claim 113, wherein the probe is a chemical compound.

116. The system of claim 114, wherein the target is a biological material.

117. The system of claim 114, wherein the target is a chemical compound.

118. The system of claim 115, wherein the target is a biological material.

119. The system of claim 115, wherein the target is a chemical compound.

120. The system of claim 114 wherein the probe is selected from one or more of the group consisting of oligonucleotides, polynucleotides, proteins, peptides, cDNA and RNA.

121. The system of claim 116 wherein the target is selected from one or more of the group consisting of oligonucleotides, polynucleotides, proteins, polysaccharides, ligands, cells, antibodies, antigens, cellular organelles, lipids, blastomeres, aggregations of cells, microorganisms, peptides, cDNA and RNA.

122. The system of claim 118 wherein the target is selected from one or more of the group consisting of oligonucleotides, polynucleotides, proteins, polysaccharides, ligands, cells, antibodies, antigens, cellular organelles, lipids, blastomeres, aggregations of cells, microorganisms, peptides, cDNA and RNA.

123. The method of claim 2 wherein the movement of at least one optical trap is selected from one or more of the group consisting of rotation in a fixed position, rotation in a non-fixed position, movement in two dimension, and movement in three dimensions.

124. The method of claim 2 further comprising moving the optical trap containing the tracked probe by changing the surface of the phase patterning optical element.

125. The system of claim 103 wherein the phase patterning optical element has a static surface

126. The system of claim 125 wherein the static surface is comprised of two or more discreet regions.

127. The system of claim 126 wherein the static surface is movable to align the focused beam of light with a selected region of the static surface.

128. The method of claim 2 wherein the phase patterning optical element has a static surface having two or more discreet regions and the position of at least one optical trap is altered by changing the discreet region of the static surface to which the beam of light is directed.

129. The system of claim 103 wherein the phase patterning optical element has a substantially continuously varying static surface.

130. The system of claim 127 wherein the phase patterning optical element is selected from the group consisting of gratings, holograms, stencils, light shaping holographic filters, lenses, mirrors, prisms, or waveplates.

131. The system of claim 126 wherein each discreet region is selected from the group consisting of gratings, holograms, stencils, light shaping holographic filters, lenses, mirrors, prisms, or waveplates.

132. The system of claim 103 wherein the phase patterning optical element is dynamic.

133. The method of claim 2 wherein the phase patterning dynamic element is dynamic and varying the phase patterning optical element alters the position of the at least one optical trap.

134. The method of claim 4 wherein the phase patterning dynamic element is dynamic and varying the phase patterning optical element alters the position of the at least one optical trap.

135. The method of claim 2, wherein the phase patterning dynamic element is dynamic and varying the phase patterning optical element changes the form of at least one of the optical traps to an optical tweezer, an optical vortex, an optical bottle, an optical rotator, or a light cage.

136. The method of claim 2 wherein the phase patterning optical element has a static surface having two or more discreet regions and the form of at least one of the optical traps is changed by moving the static surface.

137. The method of claim 136, wherein the form of the changed optical trap is selected from the group consisting of optical tweezers, optical vortices, optical bottles, optical rotators, and light cages.

138. The system of claim 132 wherein the phase patterning optical element is selected from at least one of the group consisting of variable computer generated diffractive patterns, phase shifting mater, liquid crystal phase shifting arrays, micro-mirror arrays, spatial light modulators, electro-optic deflectors, accousto-optic modulators, deformable mirrors and reflective MEMS arrays.

139. The system of claim 132 further comprising a computer to control the dynamic phase patterning optical element.

140. The system of claim 103, further comprising a sub-cell within the vessel for segregating at least one of the probe-containing optical traps.

141. The system of claim 140 wherein the sub-cell is a physical sub-cell.

142. The system of claim 150, further comprising a computer to alter the phase patterning optical element to change the orientation of at least one of the beamlets and move the corresponding optical trap in order to contain the probe.

143. The system of claim 103 wherein the light source is a laser for producing a focused beam with a wavelength in the green spectrum.

144. The system of claim 103 wherein the light source is a laser for producing a focused beam with a wavelength in the visible blue spectrum.

145. The system of claim 103 wherein the light source is a laser for producing a focused beam with a wavelength in the visible red spectrum.

146. The system of claim 103 wherein the light source produces a focused beam of light having a wavelength in the range of about 400 nm to about 1060 nm.

147. The system of claim 103 wherein the light source is a laser beam.

148. The system of claim 103 further comprising a computer for receiving the optical data-stream.

149. An apparatus to form an array of optical traps comprising:

a light source for producing a focused beam of light;

a focusing lens having a top and bottom, the bottom forming a back aperture;

a phase patterning optical element for receiving the focused beam of light and diffracting it into at least two beamlets, the phase patterning optical element having a surface for directing each of the beamlets at the back aperture of the focussing lens;

a first light channel having first and second ends, the first end in communication with the phase patterning optical element;

a second light channel having first and second ends, the first end intersecting the second end of the first light channel;

a third light channel having first and second ends, the first end in communication with the second end of the second light channel;

a first mirror for reflecting the beamlets emanating from the phase patterning optical element through the first light channel;

a first set of transfer optics disposed within the first light channel, aligned to receive the beamlets reflected by the first mirror;

a second set of transfer optics disposed within the first light channel, aligned to receive the beamlets passing through the first set of transfer lenses;

a second mirror positioned at the intersection of the first light channel and the second light channel, aligned to reflect beamlets passing through the second set of transfer optics through the third light channel; and

a third mirror disposed within the third light channel for reflecting beamlets passing through the third light channel to the back aperture of the focusing lens and forming an array of optical traps.

150. The apparatus of claim 149 further comprising an illumination source for producing a beam of illuminating light disposed next to the top of the focusing lens.

151. The apparatus of claim 150, wherein the third mirror is a dichroic beam splitter for directing the beam of focussed light originated from the light source and the beam of light originating from the illumination source.

152. The apparatus of claim 149 wherein each set of transfer optics is selected from the group consisting of symmetrical air spaced singlets and symmetrical air spaced doublets.

153. The apparatus of claim 149 wherein each set of transfer optics is comprised of lenses selected from the group consisting of convex lens and concave lenses.

154. The apparatus of claim 149 wherein the first and second sets of transfer optics are symmetrical air spaced and are spaced at a distance to act in combination as a telephoto lens.

155. The method of claim 25 further comprising introducing into the vessel at least one target and determining the reaction or lack thereof of each of the trapped probes with each of the targets.

156. A method in accordance with claim 1 further comprising moving at least one of the trapped probes by transferring the probe from one optical trap to another.

157. A method in accordance with claim 1 further comprising moving at least three of the trapped probes by transferring the probe from a first set of optical traps to a second set of optical traps.